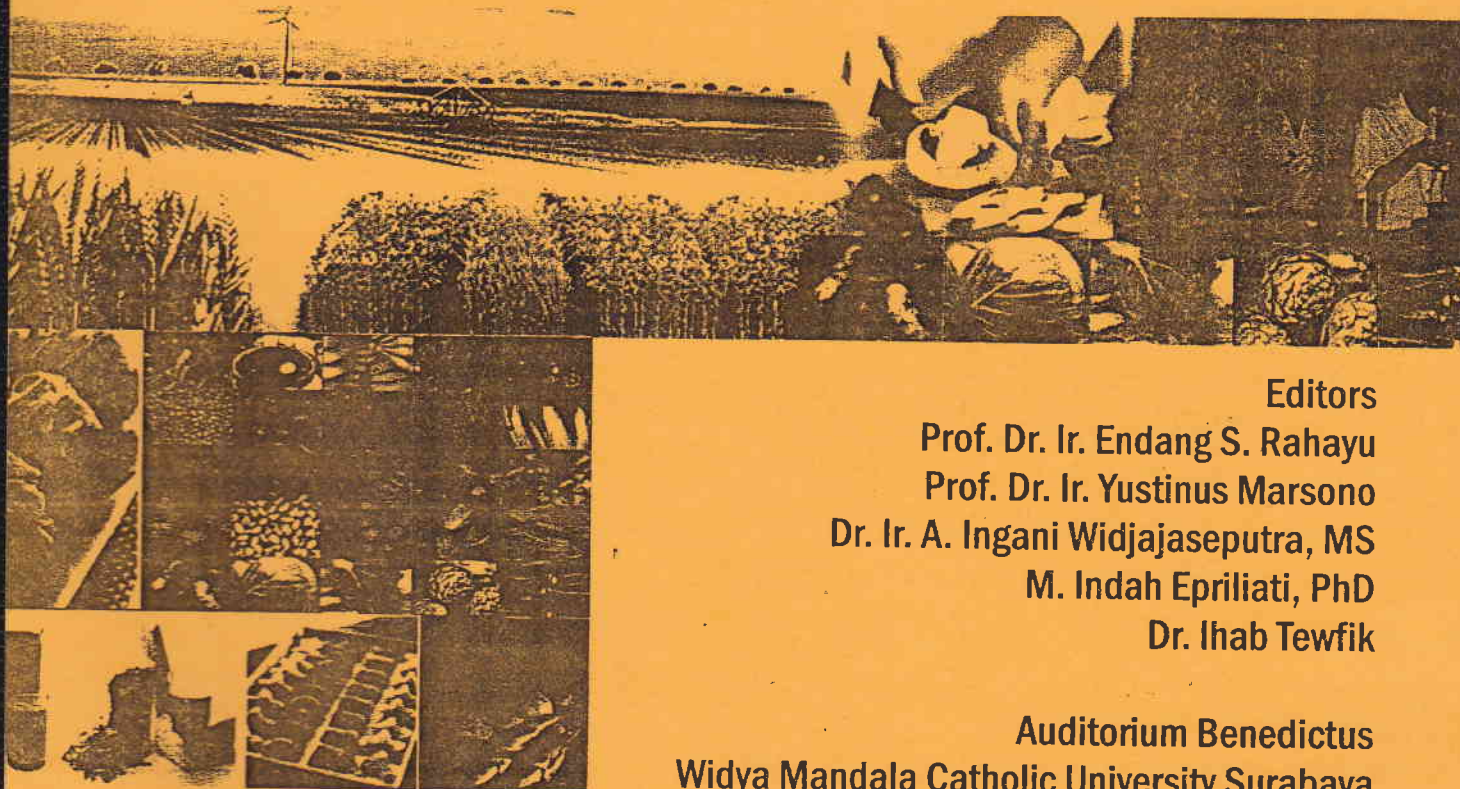


# PROCEEDING

International Food Conference 2011

"Life Improvement through Food Technology"

Surabaya, October 28<sup>th</sup> - 29<sup>th</sup>, 2011



Editors

Prof. Dr. Ir. Endang S. Rahayu

Prof. Dr. Ir. Yustinus Marsono

Dr. Ir. A. Ingani Widjajaseputra, MS

M. Indah Epriliati, PhD

Dr. Ihab Tewfik

Auditorium Benedictus

Widya Mandala Catholic University Surabaya

Supported by



World Association for  
Sustainable Development



International Forum  
For Public Health



Indonesian Association  
Food Technologist

Organized by



Agricultural Technology Faculty  
Widya Mandala Catholic University  
Surabaya

# **PAPER OF ORAL PRESENTATION (Cont'd)**

NO	AUTHOR	TITLE	PAGE
17	Gatot Priyanto, Kiki Yuliati and Lucyana	Nitrogen Gas Application for Packaging of Nila Chips on Various Storage Times and Temperatures	110-117
18	Misnawi, Ariza Budi Tunjung Sari and Shinta Setiadevi	Process of Producing Polyphenol from Unfermented Cocoa Bean Using Various Extracting Solvents	118-122
19	Junaedi Muhidong and Kartika	Volumetric-Shrinkage Model of Cocoa Beans	123-128
20	Ariestya Arlene A., Anastasia Prima K., Tisadona Mulyanto and Cynthia Suriya	Red Food Coloring Extraction From Rosella ( <i>Hibiscus sabdariffa</i> )	129-133
21	Andri Cahyo Kumoro	Preliminary Investigation on the Preparation of Wanang From Jackfruit ( <i>Artocarpus heterophyllus</i> Lam) Juice Using <i>Saccharomyces cerevisiae</i>	139-144
22	Tang, J.Y.H., Izenty, B.I., Nur'Izzati, A.J., Rahmah, S.M., Roslan, A. and Abu Bakar, C.A.	Survival of <i>Vibrio Cholerae</i> O1 in Cooked Rice, Coffee and Tea	145-152
23	Budi Sustriawan, Rahma Purnama Sari	Study of lead contaminant on seafood at seafood restaurants in Purwokerto	153-159
24	Laksmi Widajanti, Dina R. Pangestuti	Hygiene and sanitation of warung makan in Tembalang Sub-district, Semarang City, Central Java, Indonesia	160-163
25	Sabaianah Bachok, Chemah Tamby Chik, Maaruf Abd Ghani A, Aliffaizi ArsatA, Jazziana JamilA & Suria Sulaiman	The Impac of Halal Logo Implementation on Malaysian Restaurant Operators	164-167
26	Siti Nur Afifah Jaafar, Margaret Lumbers and Anita Eves	The Role of Food Quality in Determining Consumer Satisfaction, Post-purchase Attitudes and Behavioral Intentions in the Restaurants	168-176
27	Hasnelly	Strategies of Market Based on Customer Loyalty of Green Food Products in Indonesia	177-186
28	Baiq Rien Handayani And Stanley E. Gilliland	Antibacterial Activity Of Coffee Berry Pulp Fractions And Their Phenolics Content	187-194
29	Harsojo	The Effect of Irradiation And Storage On Chicken Processed Food	195-201
30	Nurhayati, B. Sri Laksmi Jenie, Sri Widowati, Harsi D Kusumaningrum	Low glycemic index modified plantain flour as functional foods	202-208
31	Jayus, Nuri and Andri Tilaqza	Anti-diabetic Activities of Ethanolic Extract of <i>Merremia mammosa</i> (Lour.) Hall. f. Tuber in Diabetic Rats by in vivo Glucose Tolerance Test	209-213
32	Tejasari and Ali Santoso	Health Effects of Nutrafosin Beverage on Lipid Profile of Patient with Dislipidemia	214-223
33	Budi Laksono, Hadisaputro Suharyo, Suwandono A, and Gasem MH	The Influence of <i>Phylanthus Niruri</i> Extract on The Progression of HIV/AIDS Infection as Indicated by Monitoring of CD4 and TNF Alpha Levels	224-233
34	Rio Jati Kusuma, Sri Lestari, Finotia Astari, Fadhila Pratamasari, and Susetyowati	Planting a hope from lactic acid bacteria: reducing the risk of cardiovascular disease in acute renal failure with black soygurt	234-240



# VOLUMETRIC SHINKAGE MODEL OF COCOA BEANS

Juwati Mubandani<sup>1</sup> and Karyati<sup>2</sup>

<sup>1</sup> Staff of Agricultural Engineering Department – Hasanuddin University  
<sup>2</sup> Senior Student of Agricultural Engineering Department – Hasanuddin University

Kampus Indonusa – IPTEK, South Sulawesi – Indonesia

Phone#: 62-0411-587 085, Mobile Phone: 02-9812 420 8206, Fax#: 62-0411-587 085

## ABSTRACT

This study was intended to observe the volumetric shrinkage of cocoa beans from several different clones during the thin layer drying process. Five cocoa clones, were used, namely Sulawesi-1, SC4-4, DRC-16, ICCRI-04 and Sulawesi-2. The thin-layer drying process was performed using a tray dryer, Model EH-TD-300 Eunha Fluid Science. Drying air velocity and temperature were set to 1.3 m/s and 47°C, respectively. Observations on dimensional reduction (length, width and thickness) were conducted on the elapsed drying time of 0, 1, 2, 4, 8, 17, 35, and 39 hours which provided eight different levels of sample moisture contents. Observed dimensional reductions were then transformed into volume shrinkage. The ratio of volume shrinkage (volume at elapsed drying time divided by the initial volume) for each cocoa clone was plotted against the bean moisture contents. Bala and Woods, Correa et al. linear, and polynomial-quadratic models were then fitted to this volume shrinkage behavior. Research results strongly indicate that among these models, the polynomial-quadratic model is the best model to represent the volume shrinkage of cocoa beans for all clones observed.  $R^2$  reaches up to 0.99.

**Key words:** volumetric shrinkage, cocoa bean, thin-layer drying

## INTRODUCTION

Cocoa (Theobroma cacao L.) is one of the primary estate crops in Indonesia. Indonesia has even been listed as the third largest cocoa producer country after Cost de Ivory and Ghana during the last several years. At the provincial level, South Sulawesi is one of the cocoa centers in Indonesia. The export value of cocoa beans from this province is tremendously high compared to other crops (Pantubun, 2004; AIKI in, 2006; and Mubidong, 2007). Nonetheless, Indonesian cocoa is considered to be a low quality cocoa and mostly unfermented. Mouldy bean is also another factor that affects the quality level (Mubidong, 2008).

As a prime estate crop, the existing of various cocoa clones may also increase the cocoa quality variability. Unfortunately,

research on cocoa quality related factors is relatively less progressive compared to the development of new clones. As a result, the engineering properties of the cocoa bean of the new clones are not well established, including the volume shrinkage of the beans during the drying process. This study was intended to observe the volumetric shrinkage of cocoa beans from several different clones during the thin layer drying process. Research on cocoa bean dimension characteristics was indeed studied by Oyedokun et al. (2011). Nonetheless, the length, width, and thickness characteristics were not linked with other parameters, such as moisture content and drying time.

The crop shrinkage, excluding recent cocoa clones, were intensively studied by some researchers. Among others, Correa et

al. (2004) observed coffee berry shrinkage. Abbasi et al. (2009) scrutinized the behavior of onion slice shrinkage during the thin layer drying process. A similar approach was also applied by Seifi and Alimardani (2010) when examined the relationship of the corn porosity and moisture contents.

## MATERIALS AND METHOD

The research was conducted during the month of June 2011 at the Processing Laboratory of Agricultural Engineering Department - Faculty of Agriculture - Hasanuddin University, Indonesia. Cocoa samples were taken from local cocoa famers in Enrekang Regency - South Sulawesi. Five cocoa clones were used, namely Sulawesi-1, SCA-6, DRC-16, ICCRI-04 and Sulawesi-2. The thin-layer drying process was performed using a tray dryer, Model EH-TD-300 Eunha Fluid Science. Drying air velocity and temperature were set to 1.3 m/s and 47°C, respectively. Observations on dimensional reduction (length, width and thickness) using a vernier-caliper were conducted on the elapsed drying time of 0, 1, 2, 4, 8, 17, 35, and 39 hours which provided eight different levels of sample moisture contents. Observed dimensional reductions were then transformed into a volume

shrinkage. The ratio of volume shrinkage (volume at elapsed drying time divided by the initial volume) for each cocoa clone was plotted against the bean moisture contents. Bala and Woods, Correa et al., linear, and polynomial-quadratic models were then fitted to this volume shrinkage behavior.

Cocoa bean volume was calculated following the method used by Corrêa et al. (2004) as follows:

$$V = (1/6) (\pi.a.b.c)$$

where:

V, a, b, and c are volume, length, width, and thickness of the cocoa bean, respectively.

The volume shrinkage ( $V_f$ ) was then calculated under the following formula:

$$V_f = V_m / V_o, \text{ where}$$

$V_m$  = Cocoa bean volume corresponding to the moisture content after the elapsed drying time m, and

$V_o$  = Cocoa bean volume corresponding to the initial moisture content.

The relationship of the  $V_f$  value and the moisture content (dry basis, d.b.) were then evaluated using the following models:

Table 1. List of equations being evaluated to present the cocoa bean shrinkage behavior.

Equation Tag	Mathematical Model
Rahman Equation (1995) <sup>*)</sup>	$V_f = 1 - b.(U - U_o)$
Adapted Bala & Wood's Equation (1984) <sup>*)</sup>	$V_f = 1 - a. (1 - \exp((b).(U - U_o)))$
Corrêa et al. Equation (2004) <sup>*)</sup>	$V_f = 1 / (a + b.\exp(U))$
Proposed Model	$V_f = a.U + b.U^2 + c$

<sup>\*)</sup> Source: Corrêa et al. (2004)

$U_o$  and  $U$  are the cocoa bean initial moisture content (d.b.) and the moisture content (d.b.) at a certain elapsed drying time, respectively.

The equations were then evaluated using the SPSS Software. The model with the highest  $R^2$  value will be considered as the best

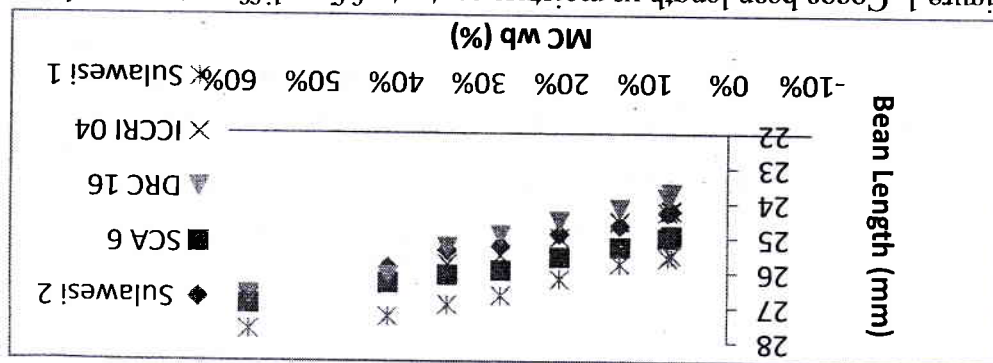
model to represent the shrinkage behavior of the cocoa bean being observed.



## RESULTS AND DISCUSSIONS

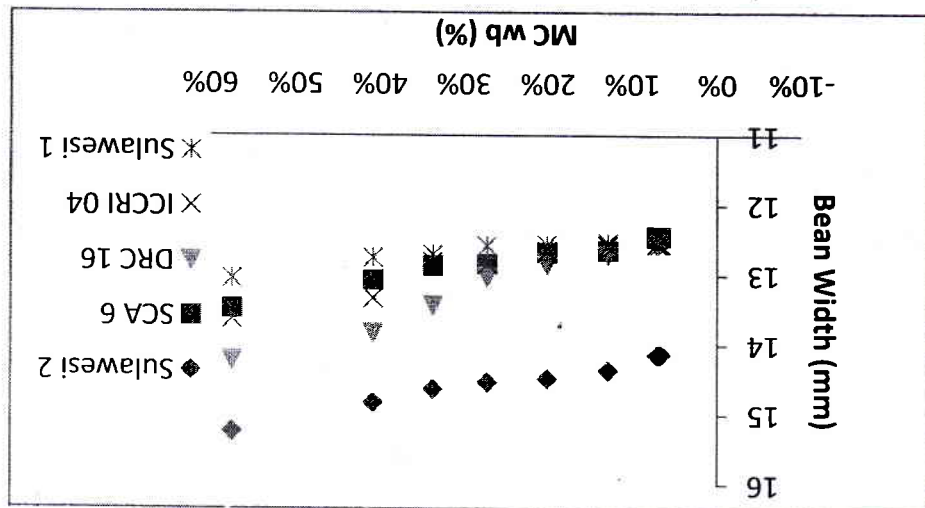
The bean length, width, and thickness reductions when the moisture contents of the cocoa beans decreased across the drying time were displayed in Figures 1, 2, and 3. These figures strongly indicated that a significant decrease on a bean length, width, and thickness occurred as the moisture content declined during the drying process for all clones observed. It was also found that the downward trend was different from one clone to another. The DRC 16 clone seemed to have a higher dimension reduction rate compared to the other clones. Unfortunately, this research was not designed to deeply explore this phenomenon.

Figure 1. Cocoa bean length vs moisture content of five different cocoa clones



Sample volume shrinkage was depicted in Figure 4. This figure even emphasized that the volume shrinkage of the DRC clone was the biggest one, consistent with its dimensional (length, width, and thickness) behavior. While the clone with the smallest volume shrinkage was found on Sulawesi-1 clone.

Figure 2. Cocoa bean width vs moisture content of five different cocoa clones



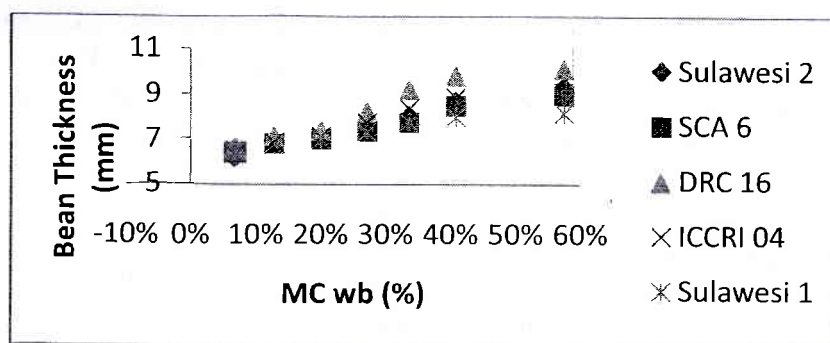


Figure 3. Cocoa bean thickness vs moisture content of five different cocoa clones

The behavior of the volumetric shrinkages as shown on Figure 4 provided an initial guess that their trends might follow linear, exponential, or polynomial manners. This was exactly in line with the four alternative models provided above. Curve fitting using the SPSS Software under the non-linear

regression facility was used to estimate all parameters (a, b, and c) involved in the equations. Their  $R^2$  values were also calculated under this facility. The result summary of this calculation was shown in Table 2.

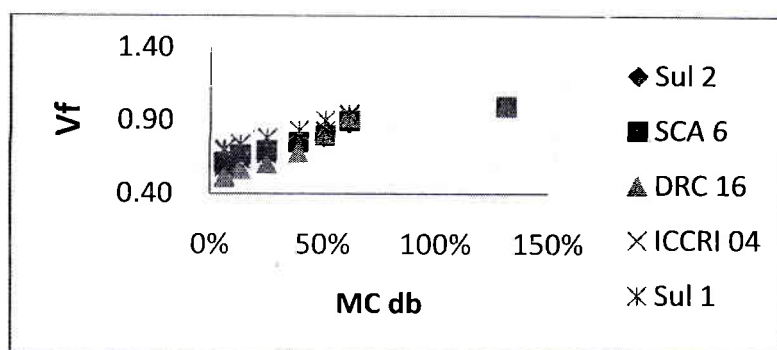


Figure 4. Cocoa bean volumetric shrinkage vs moisture content of five different cocoa clones

Table 2. The values of parameters involved in each volumetric shrinkage model being evaluated.

Equation Tag	b	A	C	$R^2$
<b>Rahman Equation (1995)<sup>*)</sup></b>				
$V_f = 1 - b.(U - U_0)$				
Sulawesi 1	-0.258			0.821
DRC 16	-0.250			0.928
ICCRI 04	-0.274			0.893
SCA 6	-0.298			0.873
Sulawesi 2	-0.315			0.907
<b>Adapted Bala &amp; Wood's Equation (1984)<sup>*)</sup></b>				
$V_f = 1 - a.(1 - \exp(b.(U - U_0)))$				
Sulawesi 1	0.003	82.107		0.821
DRC 16	0.001	276.757		0.928
ICCRI 04	0.001	271.741		0.893
SCA 6	0.001	229.364		0.872
Sulawesi 2	0.001	234.681		0.907

Table 1. The values of parameters involved in each technological storage model being

Model	SCA 6	ICCRJ 04	DRC 16	Sulawesi 1	Sulawesi 2	$V_i = a.U + b.U^2 + c$	Proposed Model
SCA 6	0.994	0.999	0.980	0.971	0.980		0.976
ICCRJ 04	0.994	0.999	0.980	0.971	0.980		0.719
DRC 16	0.994	0.999	0.980	0.971	0.980		0.707
Sulawesi 1	0.994	0.999	0.980	0.971	0.980		0.684
Sulawesi 2	0.994	0.999	0.980	0.971	0.980		0.682

Table 2 clearly indicated that the proposed model consistently provided higher  $R^2$  for all clones compared to the other models. Corrêa et al. Equation (2004) which excellently represented the shrinkage behavior of coffee berry was found to be the most under-performed in this study.

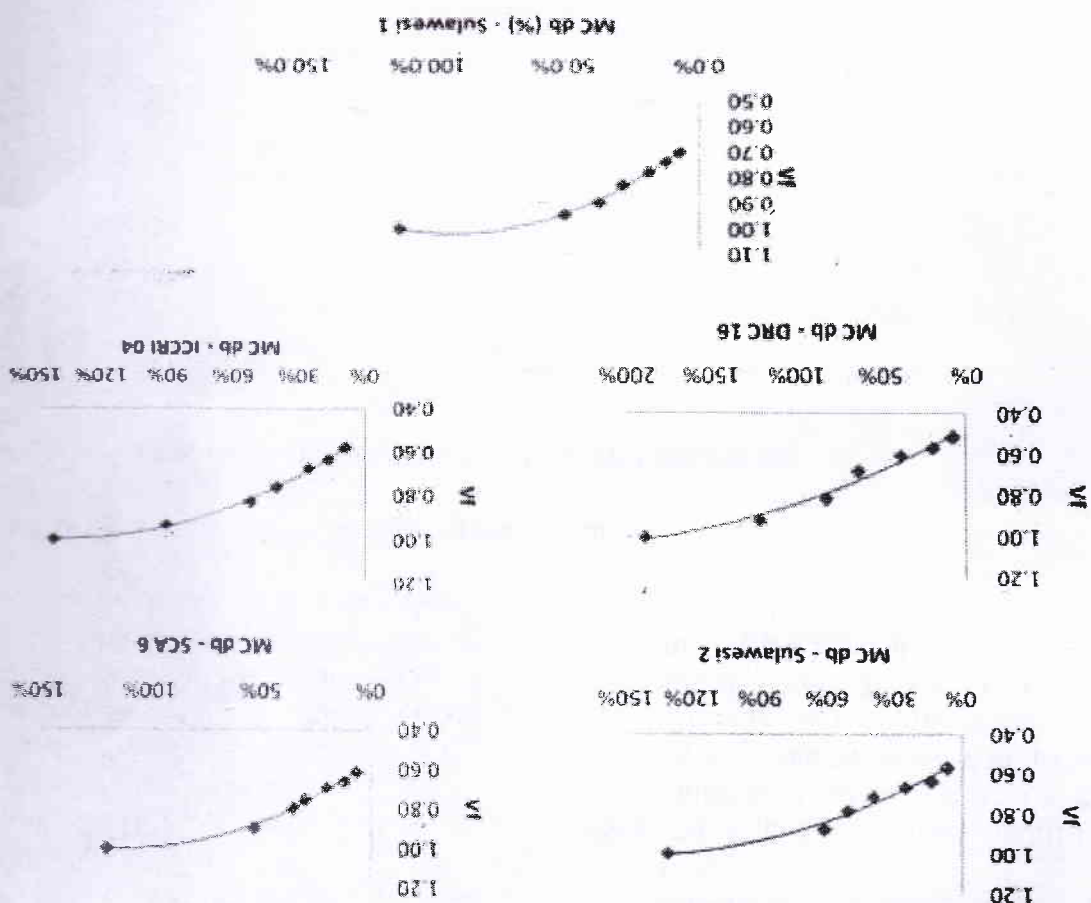


Figure 5. Performance of the proposed model (a polynomial model) in estimating the volumetric shrinkage behavior of five different cocoa clones.